INDUSTRY STUDIES 2000

Space

ABSTRACT

The U.S space industry is in a major transition from being a child of the Cold War to becoming an adolescent commercial industry. Industry growth continued this year, but the unbridled enthusiasm of the previous few years has been undermined by significant financial, technical, and policy failures affecting the entire industry. The industry faces many challenges, largely due to a significant industrial overcapacity fueled by the excessive optimism of the past decade. The key government role is to provide strategic leadership and to establish effective policies that balance the needs of the emerging commercial sector with those of national security. Issues such as export licensing, data distribution, spectrum allocation, and research and development investment decisions require thoughtful and expert government attention to move the industry from its historical Cold War roots to a viable commercial entity capable of competing in an increasingly globalized market.

Mr. David Beck, National Aeronautics and Space Administration

Lt Col Ronald Grundman, USAF

Lt Col Stephen Holt, USAF

Mr. Kelly Hughes, Defense Intelligence Agency

Mr. Alan Loosararian, National Security Agency

LTC Albert Luster, USA

CDR DeWolfe Miller, USN

Col Michael Newton, USAFR

Lt Col Richard Petrassi, USAF

LTC Ronald Pontius, USA

Lt Col Michael Ruff, USAF

CDR Barbara Scholley, USN

Lt Col Norman C. Sweet, USAF

LTC Cecilia Tyler, USA

Dr. Malcolm Vant, Canadian Department of National Defence

CDR Dennis Watson, USN

Col Mary McCully, USAF, faculty

Col Stephen Randolph, USAF, faculty

PLACES VISITED

Domestic

11th Space Warning Squadron, Shriever Air Force Station, CO

45th Space Wing, Patrick Air Force Base, FL

50th Space Wing, Shriever Air Force Station, CO

Aerospace Data Facility, Buckley Air Force Base, CO

Astrotech, Titusville, FL

Boeing Delta IV Evolved Expendable Launch Vehicle facilities: Factory at Decatur, AL, and Launch Site at Cape Canaveral Air Force Station, FL

Boeing-North American, Space Systems Division, Seal Beach, CA

F-22 Combined Test Squadron, Edwards Air Force Base, CA

Lockheed Martin Evolved Expendable Launch Vehicle Facilities, Cape Canaveral Air Force Station, FL

Lockheed Martin X-33 Plant and Launch Site, Palmdale, CA

National Aeronautics and Space Administration (NASA) Headquarters, Washington, DC

NASA, Dryden Flight Research Center, Edwards Air Force Base, CA

NASA, Kennedy Space Flight Center, FL

NASA, Marshall Space Flight Center, Huntsville, AL

National Imagery and Mapping Agency, Washington, DC

National Reconaissance Office, Chantilly, VA

Office of Science and Technology Policy, Washington, DC

Orbital Sciences Corporation, Dulles, VA

SeaLaunch, Long Beach, CA

Space-based Infrared System Ground Station, Buckley Air Force Base, CO

Space Imaging Co., Denver, CO

TRW Space Park, Redondo Beach , CA

U.S. Space Command, Peterson Air Force Base, CO

International

Aerospatiale-Matra, Les Mureaux, France and Kourou, French Guiana

Arianespace, Kourou, French Guiana

Bad Aibling Station, Bad Aibling, Germany

Centre National D'Etudes Spatiales, Kourou, French Guiana

DaimlerChrysler Aerospace, Ottobrunn, Germany

Deutsches Zentrum fürLuft-und Raumfahrt, Oberpfaffenhoffen, Germany

INTRODUCTION

United States preeminence in space has been a matter of national pride since President John F. Kennedy first announced the commitment to put a man on the moon. Since the early 1960s, the U.S. government has recognized the crucial role that space systems play in protecting national security. Today, the United States is the world's dominant space power, exploiting the high ground of space—for weather, reconnaissance, surveillance, communications, positioning, and navigation—to a degree that no other nation can. The United States leads the world in the advancement of civil space programs, including space science, space exploration, manned space, and earth observation.

Born of government requirements and investment, the U.S. space industry is in a major transition from being a child of the Cold War to becoming an adolescent commercial industry. A combination of declining government investment and the emergence of new Information Age commercial markets has driven this trend for the past decade. Commercial services offered through space include paging, mobile and remote communications, remote sensing, television broadcast, and point-to-multipoint data communications. Space-borne capabilities also enable derivative industries such as sales of Global Positioning System (GPS) navigation equipment and value-added services in imagery analysis. But, the space industry faces competition from terrestrial and airborne service providers in the same applications markets. Anything that can be done from space can also, to a greater or lesser degree, be done some other way. So, the success of commercial space ventures depends heavily on the industry's ability to bring value-added and timely capabilities to market at a cost competitive with those of other service providers and at a risk low enough to attract and retain private capital investment.

Furthermore, space remains a complex, high-technology, high-risk, high-investment industry, unusually sensitive to economic conditions, politics, and the government regulatory framework. So, while increasing commercialization of space has strengthened commercial influence over space technology development, the industry remains largely driven, and also constrained, by government investment, regulation, and licensing. Government policymakers, therefore, have a key role in enabling an effective transition of this crucial Information Age industry from its government-funded roots to a viable commercial entity in promoting the continued U.S. position of preeminence in space.

THE SPACE INDUSTRY DEFINED

The space industry is divided into four basic sectors: (1) applications, (2) spacecraft, (3) space launch, and (4) supporting services. The applications sector drives all the others, for without an application there is no need for a spacecraft, a launch, or supporting services. This sector primarily encompasses the services that are purchased or rented, such as direct-to-home (DTH) television and the equipment that enables customers to use those services. Although difficult to capture, the worldwide revenue forecast for space-based services in 1999 was more than $45 billion.[i] The spacecraft sector entails design, manufacturing, testing, and sales of the satellites that provide these services. Revenues generated by sales of commercial and government satellites reached $12.7 billion in 1999.[ii] The space launch sector covers the design, manufacturing, testing, and operation of launch vehicles. Estimated revenues generated by government and commercial launches reached $7.1 billion in 1999.[iii] Finally, supporting services covers insurance, financial, legal, and media support of space industries. The 1999 estimate of support service revenues was $3.9 billion.[iv]

The U.S. government investment in space, split almost evenly between military and civil programs, leveled off in 1998 after several years of decline and is now expected to continue at a steady expenditure rate of about $26.6 billion[v] (of the $34 billion for governments worldwide) per year for the next several years. Commercial space, though, driven primarily by growth in the applications sector, is currently enjoying a period of significant growth, having substantially outpaced government programs within the last decade. Overall, the global space industry is becoming a $100 billion enterprise, employing nearly a million people.

CURRENT CONDITION

The year 1999 saw some fundamental shifts in the space industry. While industry growth continued, the unbridled enthusiasm of the previous few years was undermined by significant financial, technical, and policy failures affecting the entire industry. Today, while sector revenues continued to grow, there appears to be significant overcapacity in the spacecraft and space launch sectors, and additional industry contraction and consolidation will probably continue. Stiff competition for U.S. industry is to be expected, as European industry has followed the U.S. model of industrial consolidation, spawning the multinational ventures by Astrium and the European Aeronautic, Defence, and Space (EADS) Company, which rival even the U.S. giants such as Boeing and Lockheed Martin in size and capability. In 1999, the financial markets strongly favored Internet companies over any other industry sector.[vi] This has resulted in lower market capitalization for many existing space companies and greater difficulty in raising funds for new and existing companies. Lockheed Martin is in a particularly weak position, with a debt-to-equity ratio approaching 140 percent.

Of the four major sectors, the applications sector generates the greatest revenue and is the only sector projecting significant revenue growth. The largest and fastest growing space application, and hence the biggest driver of this trend, is the DTH television market. Worldwide industry revenues were about $10 billion in 1999, and they are growing at about $2 billion per year.[vii] Serving a similar type of market, satellite direct digital audio is poised to be the next high-growth area, with revenues expected to reach $7.5 billion by 2007.[viii] Both of these applications are provided through cost-effective, geosynchronous earth orbit (GEO) satellites offering service to a whole continent.

After DTH, the next largest space applications market segment is in fixed communications, which have been served for over 25 years from GEO systems. Recently, data traffic has shifted from older, low-capacity C-band (5-GHz) and S-band (3-GHz) systems to high-capacity, digitally switched fiber-optic cable networks. Growth is, however, still likely in this applications market, as technology advances are enabling GEO communications satellites to participate more fully in the Internet.

A chill has fallen over the low-earth-orbit (LEO) satellite-based mobile voice market with the financial failure of Iridium, which was unable to generate enough revenue to service its huge debt load.[ix] A competitor LEO system, ICO Global, followed Iridium into Chapter 11 receivership, but was able to attract new financing. The new ICO, restructured as a medium data rate and voice system and intended to develop the market for the planned Teledesic system, now costs over $7 billion.[x] However, the costs involved in these systems seem likely to doom them to failure. Globalstar, the other main player in the mobile voice market, has a lower system cost ($4.8 billion), but is experiencing very slow sales after the commencement of its service in February 2000.[xi]

In the navigation and positioning applications area, 1999 sales of GPS units are estimated at $8 billion.[xii] On May 1, 2000, President Clinton authorized transmission of the highest accuracy GPS signals for receipt by civil and commercial receivers, thus improving performance of existing receivers by an order of magnitude to 10-meter accuracy and spurring greater growth in sales of GPS units and services.[xiii] The European Union and the European Space Agency (ESA) jointly announced plans to proceed with their own space-based global navigation system, Galileo, which they expect to provide increased availability, reliability, and accuracy over GPS.[xiv] The Galileo program will increase European autonomy from U.S.-controlled systems and represents a big step toward a consolidated European space policy.

In late 1999, Space Imaging’s Ikonos-2 satellite began supplying the world with 1-meter-resolution panchromatic and 4-meter-resolution multispectral imagery, distributing products to customers via CD-ROM and the Internet. There are other competitors planning to field comparable systems, but it is unclear how many such systems the market can support at present. The sale of value-added information such as land use data, crop management information, and fisheries maps appears to be a much more lucrative market than raw imagery sales. Value-added product sales are expected to grow from their present level of $500–$600 million per year[xv] to about $4 billion per year by 2003.[xvi]

Export licensing proved a major issue in the commercial satellite sector last year. Due primarily to two incidents of technology transfer to China, Congress transferred export licensing for satellites and their components to the purview of the Department of State. The result, according to industry representatives at home and abroad, has been a significant drop in U.S. satellite market share, driven by the slowness of the licensing process. License-processing delays are projected to cost the industry $3–$5 billion in lost opportunities over the next 18 months.[xvii]

Launch projections for the next 5 years are down significantly from last year’s outlook. This trend is driven primarily by the financial failure of Iridium and the resulting sag in the LEO satellite market.[xviii] As a result, there is now considerable projected overcapacity in the commercial launch business for the next several years.

The Europeans' Arianespace remains the world leader in commercial launches, having launched 104 (61 percent) of the 170 operating commercial telecommunications satellites in orbit today.[xix] In December 1999, the new Ariane 5 heavy lifter officially entered commercial service with a successful launch of the XMM X-ray observatory satellite.[xx] The U.S. Air Force's Evolved Expendable Launch Vehicle (EELV) program partnership with Boeing and Lockheed Martin remains the strongest U.S. response to Arianespace's commercial launch industry dominance, with the first commercial launches planned for 2001. According to an EELV program spokesman, the prospect of EELV competition is already forcing Arianespace prices down.[xxi]

A rapid-fire spate of launch failures in the 18 months since August 1998, involving the Athena, Delta, Atlas, and Titan rockets, as well as the Russian Proton, Japanese H–2, and SeaLaunch's Ukrainian Zenit, reminded the United States that space is a difficult and expensive place to go.[xxii] The resulting White House–commissioned *Space Launch Vehicles Broad Area Review* entailed a comprehensive examination of the U.S. space launch industry. The commission's report pointed to a lack of disciplined system engineering and a disturbing loss of experience and skills in the space launch industry, leading to critical gaps in expertise.[xxiii]

The National Aeronautics and Space Administration's (NASA's) ongoing program to find a lower cost, safer, second-generation reusable launch vehicle (RLV) faltered this year when the X–33's composite liquid hydrogen tank failed during pressure testing. In the wake of that failure, in February 2000, NASA announced a broadened $4.5 billion (over 5 years) Space Launch Initiative focused on second-generation RLV risk reduction and a continued transition to commercial launch services.[xxiv] NASA's goal of reducing the cost of space launch by an order of magnitude to $1,000 per pound remains elusive.

Due to industry overcapacity, private companies developing new RLVs—e.g., Space Access LLC, Pioneer Rocketplane, Bristol Space planes, Kelly Space and Technology, Rotary Rocket, and Kistler—have been stymied by lack of funds, leaving these developments stalled.[xxv]

CHALLENGES

Many of the industry's challenges lie in developing new commercial applications, often in the face of terrestrial and airborne competitors in the same markets. Many applications markets, such as mobile satellite communications, broadband satellite communications, digital audio, and value-added information from remote sensing systems are still immature markets with highly uncertain futures. Adoption of a successful business model, while racing other technological competitors to market, is a key challenge addressed in the essay section at the end of this paper.

The highest profile issue in the satellite sector is clearly export controls. The challenge faced by government regulators is finding the right balance between protection against proliferation of critical technologies and promoting a healthy satellite-manufacturing industrial base. This topic will also be addressed in the essay section.

The imagery sector presents special challenges. The U.S. government limits the image resolution and data distribution of commercial overhead imagery systems such as Ikonos. While there are other equally important factors affecting the military utility of space imagery—such as image quality, timeliness, and revisit rate—U.S. industry feels the imposed limits may affect competitiveness with foreign systems soon to offer comparable products. This development, which could present a threat to U.S. national security, is addressed in the essays.

All space systems require radio frequency spectrum to operate, and spectrum competition becomes stiffer every year, as the Information Age increasingly demands more communications bandwidth. The United States has traditionally not organized well to manage this resource. With the World Radiocommunications Conference (WRC) or the International Telecommunications Union (ITU) meeting this year, this challenge merits further exploration in the essay section.

In the launch sector, bringing the EELV launchers on line for first commercial launch next year in a market that appears unable to support all the potential commercial launch providers will be a key challenge. As the Ariane 5 becomes fully operational next year, international competition will continue to stiffen. Also, regaining confidence in the reliability of existing U.S. launch systems and preparing for transition of all Department of Defense (DOD) launches to EELV will present many technical and programmatic challenges.

Of particular concern will be the ongoing loss of experience and skills across the entire space industry, which will probably continue to track the poor performance of the broader defense industrial base, as higher flying "dot-coms" continue to attract top engineers.

OUTLOOK

A common theme throughout the space industry is overcapacity fueled by the excessive optimism of the past decade. Several of the developing applications markets—mobile satellite communications, broadband satellite communications, digital audio, and value-added information from remote sensing systems—fueled that optimism, but these remain immature markets. Just as LEO-based mobile voice communications seems to be a failed concept due to the large up-front cost for the constellation, the outlook for broadband LEO systems such as Teledesic (estimated to cost $9 billion) and Skybridge (at $4.8 billion) is very tentative.[xxvi],[xxvii],[xxviii] Still, optimism may be warranted in some emerging applications, like GEO broadband communications.

When launched in 2002, the new-generation broadband, Ka-band (20-GHz) GEO satellites, enabled by ongoing advances in electronics, solar cells, batteries, and signal-processing technologies, are expected to regain some market share from fiber networks. A single Ka-band satellite, such as Astrolink, could generate the revenue of today's entire fleet of 20 or so Intelsat satellites, or about $1 billion per year. Even though the new systems will cost about twice as much as the current generation of satellites to build, there should be an order-of-magnitude improvement in cost per bit moved, making GEO satellites competitive with fiber systems.

Europe's decision to build the GPS-like Galileo could enable further development of high-assurance positioning and navigation applications, such as Instrumented Landing Systems. In a strong show of commitment, the European Union and ESA have earmarked $900 million for the program for 2000–2006. What may be even more important is that the business plan for Galileo anticipates the European market for user equipment and services will be $250 billion for the period 2005–2025.[xxix] Galileo raises concerns, however, about its interoperability with existing GPS receivers and whether its frequency will conflict with U.S. requirements.

The U.S. space-imaging industry will continue to be constrained by the government through shutter and export controls. These new imaging systems have the potential to widen the bilateral transparency enjoyed by the intelligence communities of the United States and Russia to multilateral, if not global, transparency. This new transparency, and trust it could engender, is juxtaposed against security considerations.

Evaporation of the optimism about the number of global LEO telecommunications systems to be built has led to a slowing in the conversion of the industry from producing individual handcrafted satellites to a production line manufacturing model. Hence, the hoped-for surge capability in satellite production probably will not materialize, and the military will not reap the benefits of improved production processes spun off from the commercial industry. However, as the DOD looks increasingly toward commercial satellites to handle requirements previously accomplished by DOD organic space assets (e.g., communications, imaging, remote sensing), the concern over continued commercial viability of the industry increases.

In the launch sector, the commercial competitiveness of EELV is a concern. Even if EELV providers can compete effectively in the international price battles, they could lose the market share war. The commercial satellite industry chooses launch providers on the basis of price, capability, reliability, and availability. The reliability of the EELV system is as yet unproven, and availability or responsiveness could prove to be a critical factor. Insufficient infrastructure and lack of flexibility at current U.S. launch ranges, and a constraining legal framework, continue to hinder U.S. competitiveness.

Market capitalization of aerospace companies is a major concern. At the end of 1999, the market value of the entire industry was significantly lower than that of many common manufacturing, retailing, and services companies. Unfortunately, space industry overcapacity, low profit margins, poor stability of sales, and high technical risks will likely continue to be major factors keeping market values low over the coming years.[xxx] This low equity value seriously hurts the industry's ability to borrow money or raise capital, meaning that the full cost of many space products and services, as well as most of the research and development (R&D) burden, will necessarily fall to the government for the foreseeable future.

GOVERNMENT GOALS AND ROLE

The key government challenge is to provide strategic leadership and to establish policies that effectively balance the needs of the emerging commercial sector with those of national security. Issues such as export licensing, data distribution, spectrum allocation, and R&D investment decisions require thoughtful and expert government attention to transition the industry from its historical Cold War roots to a viable commercial entity capable of competing in a globalized market.

The U.S. government leadership should focus on policies to make the satellite industry more flexible, agile, and competitive to enable more rapid spacecraft development and deployment. Export license streamlining and continued acquisition reform to enable a creative government–industry partnership should be focus areas.

In addition, the U.S. government should devise a plan to support long-range space technology R&D. Given the current state of the industry, private firms will be unable to make investments that offer little to no short-term return. Cooperative arrangements with government laboratories, industry, and universities are avenues to explore.

A domestic launch capability is fundamental to the nation's position of space preeminence, but the cost of that capability is significant. As a result, DOD and NASA budget pressures have focused the U.S. launch community on cost savings programs through commercialization and privatization initiatives such as EELV and X-33/VentureStar, as well as initiatives to increase the commercial share of range operations costs. It may be necessary to reexamine these initiatives in light of expectations of little to no commercial launch market growth for the next several years. Export policies and incentives specifically designed to encourage and support the competitiveness of U.S. launchers on the international market may be warranted. The government should be prepared to pursue industrial policy–based acquisition decisions if the industrial base fails to withstand the pressures of the commercial market.

At the same time, the government has a crucial role in developing technologies to lower the cost and risk of access to space. The expense for current-day launch systems is prohibitive, and changes will be necessary if the industry is ever to "operationalize" access to space. Therefore, advanced technologies for launch are key to the long-term space future of the United States. Because RLVs can be reused many times, they may be less expensive to operate than ELVs in the long run, but the cost and time to develop an operational RLV capability will be considerable.[xxxi] So, while the NASA Space Flight Initiative RLV investment plan should address the long-term RLV challenges, a robust ELV technology investment should also be pursued.

Finally, given the U.S. history of poor preparation for the world's periodic forums for spectrum allocation, the government should take the lead in developing a unified national position on spectrum allocation for future WRCs.

CONCLUSION

The U.S. space industry is able to support national goals. However, with the financial failure of Iridium and the difficulties being experienced by other LEO projects, the explosive failure of many U.S. launchers over the past year, and the U.S. failure to effectively transition export-licensing procedures to the State Department, investors have become increasingly wary. Moreover, other application areas, such as broadband LEO communications and imaging, are still immature, making it difficult to assess their potential for future profits with any certainty. Thus, the prospects for the industry fall significantly short of last year's rosy projections.

The reduction and delay in anticipated LEO constellations has resulted in significant overcapacity in the satellite and launch vehicle manufacturing industries, leading to what some officials deem an unhealthily high level of competition. As a result, satellite and launch vehicle companies are struggling to survive—consuming their R&D seed money and losing talent and capital to other more lucrative industries. This industry will likely see further consolidations and failures as the post–Cold War business contraction continues.

Furthermore, the anticipated transition from handcrafted manufacture of satellites to high-volume commercial production lines has slowed. This could mean a loss of potential cost savings and production process spin-offs that could have otherwise been available for national security space systems.

Despite these problems, the U.S. space industry in the aggregate is still preeminent in the world. For the next 5–10 years, the question is not, "Can the industry meet the national security needs?" but rather "Will the United States continue to build on the achievements of the past five decades?"

Space is a high-technology, expensive business, highly sensitive to government policies and regulation, international politics, and world capital market fluctuations. The government role in this industry is critical, but government policy is not keeping up with the dynamics of the industry at large. Effective action on a number of issues will require that the government balance industrial base and commercial competitiveness considerations against national security goals. Issues such as export licensing, shutter control, and spectrum allocation all demand thoughtful and expert government attention.

Key policymakers must understand the intricacies of the space business if they are to be able to play this crucial role. Otherwise, current U.S. dominance in the exploitation of space may be at risk.

ESSAYS ON MAJOR ISSUES

THE NEW SPACE-BASED TELECOMMUNICATIONS BUSINESS CASE

Malcolm Vant and Norman C. Sweet

In just the last few years, the entire commercial approach to space-based telecommunications has undergone a substantial change. In the time that it took the Iridium program to go operational, the proliferation of terrestrial fiber and the capabilities of the GEO systems rendered it obsolete. Despite all the hyperbole over what seemed like a sure thing, the Iridium program is now an expensive and visible failure; furthermore, Globalstar is still quite expensive, with few subscribers paying fees. The prospects for ICO Global's commercial success are dubious at best, and Ellipso and Constellation, two other LEO systems, are without adequate funding. The venture capitalists have taken their money elsewhere. Generating the billions required for large space constellations is now more difficult than ever.

Regional GEO Ku-band systems such as ACeS and Thuraya are now, or will soon be, covering the Middle East, North Africa, and most of Asia with direct-to-cell-telephone type handsets.[xxxii] These new systems offer essentially the same capability as Iridium and are almost an order of magnitude cheaper ($800 million–$1 billion). Although the GEO systems offer regional versus global coverage, their lower cost and their service start this year make for a more attractive business plan than that for LEO systems. This overall transition in space-based communications has been swift and, for several new ventures, catastrophic.

The same concerns are being seen in the broadband data LEO systems, the largest being Teledesic and Skybridge. These systems cost billions ($5–$10 billion), and they are also having trouble attracting venture capital. There is now so much competition from fiber and GEO satellites with very small aperture terminals (VSATs) that broadband LEO systems will be hard-pressed to maintain competitive rates.

Perhaps the final nails in the coffin for broadband LEO concepts are the GEO Ka-band satellites that promise to radically alter the previous business model. This new concept is forecast to offer usage costs in the range of 5–50 cents per megabit versus terrestrial service costs of 20 cents to a dollar.[xxxiii] As rapidly as new technology made the LEO systems look attractive, technology has again opened up new capabilities with the GEO systems. Higher frequencies, meaning smaller dishes (VSATs) and greater re-use, and on-board processing, meaning "bandwidth on demand," may become a reality. The major players, Astrolink (Lockheed Martin, TRW, and Telecom Italia) and Spaceway (Hughes) are advertising 58- to 100-spot beams, and combined with on-board processing, they could be an order of magnitude more efficient than the new Ku-band satellites.[xxxiv] This new bandwidth-on-demand technology may finally allow them to become "terrestrial fiber beaters."

The two final questions for this new telecommunications business model boil down to money and time. Astrolink has 60 percent of its necessary financing, and Hughes says that it has all it needs (acknowledged to be $1.3 billion). More important, Astrolink is advertising service within 3 years (first quarter of 2003), and Spaceway is promising its first launch and service in 2002.[xxxv] Judging from the evaporation of the Iridium business approach it is unclear whether 2–3 years to market will be soon enough. Regardless, the pace at which this new GEO/terrestrial communications business model has affected the LEO approach has shocked the industry and served as a sobering wake-up call. More important, the implications of this new model pervade the entire industry and affect the nation's security. First, the number of forecast launches per year has dropped to 30–35 (more heavy GEOs), not the 50–60 previously planned for medium LEOs. This situation poses an obvious question: Is that enough of a market for two U.S. EELV contractors, along with their international competitors who already have market share? Second, there may be less commercial technology spin-off. Beyond the impressive on-board processing technology on the horizon, the LEO systems were making great headway in production line techniques, standardization, intersatellite links, and size and weight reductions for satellites in general. The maturation of these ideas is certain to fade if the LEO systems are not built. Third, it is clear that financing for future space ventures will be harder to obtain. Space systems are not cheap, and while reduction in numbers of systems and launch vehicles across the board may mean cheaper constellation costs, the capital required for development and launch will remain high. That makes it a tough sell on Wall Street.

Finally, the national security implications are of concern. In similar fashion to strategic airlift, the forecast aggregate number of space-based "tails" is falling significantly. This calls into question the surge capacity for military operations using the previously planned LEO systems (our "CRAF fleet" in space). The global nature of these satellites made them excellent candidates for supporting worldwide military operations. While there will obviously be some new capability from regional GEO systems, they will certainly be harder to access, and a premium will probably be paid for their use during any military operations.

After several years of "wild-eyed" enthusiasm, 1999 represented the first "strategic pause" in the commercial space telecommunications business. Despite the pause, the industry continues to adapt rapidly, and the pace will likely accelerate. The next few years will be interesting.

THE EFFECTS OF EXPORT CONTROLS ON THE SATELLITE INDUSTRY

Michael Newton, Cecilia Tyler,

and Stephen Holt

Recent changes in export control laws have had a profound impact on the U.S. space industry. In 1998, allegations that the People's Republic of China (PRC) stole information on U.S. nuclear warheads were coupled with charges that four U.S. satellite and launch services companies had conducted unauthorized transfers of dual-use technologies to the PRC. In response to these allegations and concerns over unauthorized transfers of technology to the PRC, Congress passed the Strom Thurmond National Defense Authorization Act for FY 99 in October 1998. This law transferred the export licensing of commercial satellites from the Department of Commerce back to the Department of State, effective March 15, 1999.

The new law imposed special export controls on satellites launched in certain foreign countries. It significantly expanded what was covered by the Munitions List, specifically mentioning all "spacecraft, including commercial and military communications satellites, navigation satellites, experimental and multi-mission satellites." These requirements were implemented through amendments to the International Traffic in Arms Regulations (ITAR) of the State Department, which outline the process for licensing items on the Munitions List. The ITAR amendments further expanded the requirements for technology transfer control plans, imposed mandatory licensing requirements for exports to foreign satellite insurance providers, and specifically eliminated important exemptions for technical discussions with Canadian companies. Finally, ITAR included special export controls that allowed the denial of export licenses to any destination, including North Atlantic Treaty Organization (NATO) allies, as deemed appropriate for U.S. national security—a clause that has had significant consequences throughout this global industry.[xxxvi]

These consequences take on much greater significance when considered in light of the contribution of the satellite-manufacturing industry to the U.S. economy. In 1998, the U.S. commercial space industry produced $30.7 billion in revenues (including service revenues) and an $11.5 billion trade surplus.[xxxvii] In fact, the aerospace industry as a whole, of which satellite sales were a major contributor, generated the largest trade surplus ($41 billion) of all U.S. industries—three times higher than the next major surplus industry and higher than the rest of the major industry surpluses combined.[xxxviii] More than 60,000 people were employed in satellite manufacturing in the United States alone.[xxxix] Most significant, the Commerce Department has estimated that total revenues generated over the lifetime of the 29 commercial satellites licensed in 1998 would be $2.8 trillion.[xl]

The new export-licensing policy has seriously affected this vibrant industry. First, the process consumes far more time than was previously required for license decisions. More subtly, it imposes a higher degree of uncertainty and risk on U.S. satellite projects, even satellites launched on U.S. boosters, since the space insurance industry is nearly all based overseas. In a sense, the new policy represents a form and degree of unilateral export control not encountered by other global competitors, thus placing the U.S. industry at a competitive disadvantage.

Chronic personnel shortages at the State Department have led to considerable increases in license-processing times. The average processing time for satellite export licenses has increased from 144 days under Commerce to 244 days under State.[xli] Total processing time and overall complexity have frustrated U.S. industry and its international partners. While there is a clear need for export control procedures in the furtherance of national security, the current process is in need of repair.

The most telling impacts are on the bottom line in the U.S. aerospace industry. Orbital Science Corporation lost a satellite bus sale to Canada, which subsequently headed offshore,[xlii] and a 1997 Hughes Electronics license to export two telecommunications satellites to the PRC was suspended (1999). The effect: Hughes was forced to default on a $450 million contract and also had to pay $92 million in contract penalties.[xliii] Last year, Lockheed Martin Corporation could not bid on a European television broadcast satellite worth $100 million because its representatives could not navigate the export process quickly enough to meet the deadline.[xliv]

These delays and the risk that they impose have had severe effects on the industry, effects that may prove irreversible. In 1998, new satellite export sales dropped from $578 million to only $354 million, a 40 percent decrease.[xlv] In the space industry, the satellite is a very small portion of the system: the real profit is in the value-added services enabled by the satellite, with dollars in the trillions. For domestic firms, the recent sales loss translates to a $3–$5 billion loss over the next 18 months and the possible elimination of more than 20,000 jobs.[xlvi] From a strategic perspective, the current licensing process is accentuating the divide between the U.S. space industry and overseas manufacturers, for international cooperative ventures are now at greater risk for delay or cancellation.

Recent DOD and State Department policy initiatives show promise in reversing some of the problems in the current process. These efforts should be vigorously pursued through the implementation phase. In addition, given the scale of the issue, there should be a fundamental review of this entire area early in the next Administration, with three guiding principles:

1. A clarification of key technologies that the United States must protect. Instead of handling the approximately 48,000 annual license applications individually, the State Department should identify the critical technologies with the help of the DOD, the Department of Commerce, and industry, and exempt the licenses covering technologies that are not considered critical. This approach would focus on the U.S. "crown jewels," those truly critical technologies, and move the "Radio Shack" examples out of the limelight.

2. A stratification of the nations that the U.S. space industry deals with regularly. One category should include China, along with other rogue nations such as North Korea, Iraq, and Pakistan. Clearly, the United States must scrutinize these applications very closely. Another category encompasses close allies, including many NATO members. Of late, there has been encouraging dialogue in Congress relating to improvement of the process for our European space industry partners. They have complained bitterly to the State Department about the new export control process, asserting that it seriously impedes defense cooperation and hinders interoperability and coalition operations. Exports to these selected NATO partners and other close allies should be reviewed and put through a highly streamlined license application process.

3. Licensing by major project, covering a complete weapon system. This approach is currently in use by NATO allies on the Eurofighter. They call it a "global project license," which is good for 2 years, then renewed after a brief review. This approach would prolong the initial license approval, but subsequent data and technology exchanges would be much quicker. The concept is currently under discussion within the DOD and the State Department.

Implementing these recommendations will result in far fewer license applications and a streamlined review process that results in minimal delay. These changes in policy should be accompanied by the application of information technologies and additional personnel to the licensing process to reduce the administrative workload and speed up processing times. This step should be taken immediately, regardless of the decisions made in the broader policy arena.

The bottom line: space-based capabilities are vitally important to the country's future. National policies must permit the industry to compete effectively in the global marketplace.

LEVELING THE COMMERCIAL REMOTE SENSING

PLAYING FIELD

Norman C. Sweet

This past year saw another major event in the space industry: the successful launch and operation of the Ikonos-2 satellite. Ikonos-2 has the distinction of being first to market in the very high resolution (less than 1 meter ground sample distance) remote sensing market. The implications of commercial high-resolution imagery are profound, and some industry watchers predict that there may eventually be more than 30 remote sensing satellites providing imagery to anyone who can afford it.[xlvii] After several initial systems failures (Ikonos-1, Earlybird-1) and given current market realities, that number may be quite optimistic. But the result is clear: the high-resolution "high ground" will no longer be the sole purview of the superpowers. Crisp images from this ultimate vantage point will now be for sale to countries and individuals across the globe. Private organizations are already trying their hands at overhead reconnaissance. Most recently, the Federation of American Scientists posted images of Pakistani nuclear test sites on their Web site to influence public opinion prior to President Clinton's visit to South Asia.

Presidential Decision Directive (PDD) 23, U.S. Policy on Foreign Access to Remote Sensing Space Capabilities, signed in March 1994, enabled this surge of new development in the U.S. remote sensing industry. It closely followed the Land Remote Sensing Act of 1992 (P.L. 102-555), which attempted to push "international leadership in remote sensing." In the aftermath of the LANDSAT decision (limiting LANDSAT spatial resolution) and the resulting development of the French SPOT system, P.L. 102-555 and PDD 23 were attempts to level the international playing field for commercial remote sensing. These documents removed previous technical and licensing restrictions to ease entry into the commercial market. Several U.S. companies responded by building state-of-the-art commercial satellite systems.

The first of those functioning systems is now on orbit, and Space Imaging, Inc., is pushing hard to corner a major share of this evolving market. PDD 23 establishes the national objective of "supporting and enhancing U.S. industrial competitiveness in the field of remote sensing capabilities while at the same time protecting U.S. national security and foreign policy interests."[xlviii] While there is no guarantee that the United States will corner this new market, the following recommendations will go far toward ensuring that the U.S. government provides the industry with a level playing field:

1. Continued judicious use of shutter control. Both P.L. 102-555 and PDD 23 contain provisions to restrict, for purposes of national security, the collection and distribution of imagery data. This capability should be exercised sparingly for a variety of reasons. First, aside from the legal implications of the restriction of free speech (or data), meeting the "clear and present danger" proof established by the courts will be difficult. More pragmatically, any shutter controls will tend to drive potential customers away. To meet the intent of PDD 23, U.S. industry must be allowed every opportunity to expand its customer base. The alternative is to again increase the incentives for other countries to build more capable systems similar to SPOT. Finally, in virtually any shutter control scenario, the U.S. government will in all likelihood purchase as much imagery as it can. Therefore, it is not a matter of turning the sensor off, but of delaying the subsequent release of information posing a "clear and present danger" until that danger has subsided. The U.S. government gets more high-quality imagery, the vendor generates revenue, and other customers will continue to see U.S. industry as reliable.

2. Cooperative investment in the second-generation high-resolution system. As this commercial market rapidly matures, the government should move immediately to formalize a partnership with these new U.S. vendors. This partnership should include two major components:

    a. Elimination of restrictions on new technology development consistent with the earlier export control recommendations. Examples include higher resolution (0.25-meter panchromatic and 3-meter radar have already been proposed), more spectral bands, improved downlink rates, and data compression. These capabilities will enable commercial vendors to meet a broader range of DOD requirements, while allowing U.S. vendors to stay ahead of the international competition in this high-technology race. This commercial competition will also allow the government to leverage commercial R&D activities as the vendors push their development for profit motives. The last National Defense Panel estimated (perhaps optimistically) that 70 percent of military space requirements will migrate to commercial platforms this decade.[xlix]

b. Most significant, the establishment of a formal anchor tenancy relationship with these U.S. vendors. This is effectively an investment in the companies' second-generation development in exchange for direct involvement in requirements development, access to imagery data and value-added services, and more control over system tasking. The National Reconnaissance Office (NRO) and National Imagery and Mapping Agency have taken the first small steps in this direction by budgeting for imagery purchases from several U.S. remote sensing companies. These first-generation systems do meet some of the moderate-resolution needs for DOD activities, and the DOD is just beginning to take advantage of this new capability. Anchor tenancy would go beyond these first steps to establish a standing relationship. Such a relationship offers several advantages to the DOD: better satisfaction of evolving DOD and other U.S. government requirements; the opportunity to augment (or reduce) the NRO's Future Imagery Architecture; real-time access to high-quality commercial imagery and involvement in the tasking processes; and, most important, more direct control over any significant national security issue.

The bottom line: the imagery genie is out of the bottle. Attempting to stuff it back in through regulation, licensing, and security controls will only force the solution offshore. Such measures would forfeit any opportunity for the U.S. space industry to retain a clear market niche and thus meet the intent of PDD 23. The most effective way to ensure national security in this area is to do everything possible to ensure that U.S. companies have a chance to compete effectively to control the high ground.

A NEW APPROACH TO THE WORLD RADIO COMMUNICATIONS CONFERENCE: PROTECTING U.S. ACCESS TO SPECTRUM

Ron Pontius

Spectrum is the lifeblood of the space industry; its availability is critical to the future health of the industry and its ability to meet national security requirements. Accordingly, this finite and precious resource has become the subject of intense international competition. Firms and nations constantly vie to control key portions of the spectrum. That competition grows more intense daily, as emerging technologies drive an increased demand across a range of users. Almost every aspect of space activity—control, operation, and use of satellites; satellite-based services; launch range and reentry requirements—is highly dependent on the availability of the spectrum.

At the national level, several congressional and administrative reviews over the last decade have recognized the critical role that the spectrum plays in U.S. national security and economic prosperity. Various initiatives aimed at better use and management of the spectrum have already been implemented. Included are the reallocation of the spectrum from the federal government to the private sector, movement to market-based spectrum allocations and auctions in the private sector, and improvements in the national management structure for frequency allocation.

This issue is complex technically and organizationally. At the national level, the Federal Communications Commission (FCC) oversees use of the spectrum by the private sector and all state and local government users, while the National Telecommunications and Information Administration (NTIA) manages spectrum use by the U.S. government.

At the international level, the ITU, a United Nations agency with 188 member countries, is responsible for standardization, coordination, and development of international telecommunications infrastructures. Through the ITU, governments and private companies coordinate in resolving issues related to the establishment and operation of telecommunications networks and services, including space and spectrum issues. The ITU pursues its mission of allocating, regulating, and managing spectrum resources through the deliberations of the WRC. The WRC uses these conferences to make changes to the International Table of Allocations and to revise the Radio Regulations. These decisions are made on a "one nation–one vote" basis.

For the ongoing WRC, the top five issues from a U.S. government perspective are all space related.[l] Decisions made at this and subsequent WRCs will affect every segment of the industry: orbit selection, number and size of satellites, frequencies, modulation techniques, on-board processing, transponders, antennas, intersatellite links, and satellite control.[li]

The State Department is responsible for representing the United States in all international telecommunications forums, including the WRC. Traditionally, however, the State Department's preparations begin only about 6 months prior to each WRC, with the designation of the U.S. delegation. Recommendations from the FCC and the NTIA drive the national position at the WRC, except in those rare instances where they are unable to reach agreement; then the head of delegation sets the national position. This process leaves the United States at a significant disadvantage in international negotiations, where it faces competitors who employ permanent organizations to carry their requirements into the international arena. Common to after-action reports from past WRCs are proposed upgrades of this national process; from all indications, however, the WRC now under way will reflect this same approach. The United States faces real danger of losing critical capabilities if this deficiency is not repaired.

Improvement in the government's coordination, management, and use of the spectrum, domestically and internationally, will require the following:

1. A comprehensive, visionary national management strategy that

   a. Addresses near-term issues and provides a long-range plan for the use and management of this finite national resource.

   b. Provides a basis for negotiating positions in the international arena that reflect international realities and competing interests.

   c. Drives a coherent, balanced, prioritized process that maximizes efficient and effective use of the spectrum to enhance our national security, bolster our economic prosperity, and sustain public safety.

2. A permanent core delegation at the State Department to represent the United States in all negotiations of international telecommunications issues at the ITU and the WRC. This would be similar to the U.S. Trade Representative for international trade issues.

Given the one nation–one vote structure of the ITU, the United States must improve its preparation and coordination of spectrum issues, nationally and internationally, to secure U.S. interests. Now is the time to reform this process—before the next WRC. Failure to aggressively link long-term international policy efforts with domestic spectrum requirements could threaten U.S. technological and policymaking leadership.[lii]

Sources:

[i] International State Business Council, *State of the Space Industry 1999* (Washington, DC: Space Publications, 2000), 7.

[ii] Greg Caress and Ron Stearns, "Space & Satellites: A Review & Future Survey," *Space News Directory of Worldwide Space*, 7.

[iii] International State Business Council, *State of the Space Industry 1999*, 24.

[iv] International State Business Council, *State of the Space Industry 1999*, 57.

[v] NASA's fiscal year 2000 request is $13.58 billion and OMB reports DOD's fiscal year 2000 request is $13.026 billion. Source: Marcia S. Smith, *U.S. Space Programs: Civilian, Military, and Commercial*, CRS Issue Brief [summary page], 23 November 1999.

[vi] David Ignatius, "Defense Midgets," *The Washington Post*, 13 February 2000, B-7.

[vii] Euroconsult, *Corporate Profiles: 50 Satellite Operations*, 1999 edition, http://www.euroconsult_ec.com/images/pdf/corporate_profiles.pdf, 14.

[viii]International Space Business Council, *State of the Space Industry 1999.*

[ix] Iridium sought to market itself to high-end business customers who would be traveling the world, including to many areas not supported by terrestrial communications infrastructure. Handsets were to cost several thousand dollars, and calls were to cost $4–$5 per minute. Source: Michael A. Dornheim, "Iridium, Overcapacity Worry Space Industry," *Aviation Week and Space Technology* 152, no. 15 (10 April 2000): 34, 51.

[x] P. Selding, "ICO System Cost to Rise 69 Percent," *Space News This Week* (13 March 2000).

[xi] "Globalstar Sales Not Blasting Off," *Wireless Today* 4, no. 19 (31 January 2000): 1.

[xii] U.S. Department of Commerce, *US Industry and Trade Outlook '99* (New York: McGraw-Hill, 1999), 30-25.

[xiii] "President Ends GPS Selective Availability," *Global Positioning and Navigation News* 10, no. 9 (3 May 2000): 1.

[xiv] C. Bulloch, "ESA Minister's Change of Heart," *Interavia* 54, no. 632 (June 1999): 51.

[xv] International Space Business Council, *State of the Space Industry 1999*, 52.

[xvi] Euroconsult, *Corporate Profiles.*

[xvii] V. Loeb, "US Satellite Sales Lag since Regulator Shirt," *The Washington Post*, 28 March 2000, A21.

[xviii] Frank Sietzen, *FAA Predicts Slower Growth in Commercial Launches,* 9 February 2000,

www.space.com.

[xix] Douglas Heydon, *Arianespace—The Reference Launch Service*, briefing to ICAF Space Industry Study Group, Washington, DC, 28 April 1999, Chart 48.

[xx] *About Arianespace, Milestones*, 3 April 2000, http://www.arianespace.com/about_milestones.html.

[xxi] *Evolved Expendable Launch Vehicle (EELV) Acquisition Strategy*, Version 3.0 (5 June 1998), i.

[xxii] While the Atlas, Delta, and Titan programs had historically experienced an average of only one failure per year in 200 launches over the past 12 years, that failure rate climbed to five failures in less than 1 year over the period examined. Source: Institute for Defense Analysis, *Space Launch Vehicles Broad Area Review Report* (Alexandria, VA: November 1999).

[xxiii] The report found reductions of in-house engineering capability on the order of 50–60 percent in both government and contractor staffs. Source: Institute for Defense Analysis, *Space Launch Vehicles Broad Area Review Report* (Alexandria, VA: November 1999).

[xxiv] Art Stephenson, speech to FAA 3rd Annual Commercial Space Launch Forecast Conference, Pentagon City Best Western Hotel, 8 February 2000.

[xxv] William B. Scott, "Cash-Starved RLV Firms Remain Grounded," *Aviation Week and Space Technology* 151, no. 24 (13 December 1999): 79.

[xxvi] http://www.analysys.com/produsts.satellite/profiles/teledesic.htm, accessed 12 April 2000.

[xxvii] http://www.analysys.com/produsts.satellite/profiles/skybridge.htm, accessed 12 April 2000.

[xxviii] Michael Dornheim, "Iridium, Overcapacity Worry Space Industry," 34.

[xxix] O. Sutton, "Galileo: Moneypot for Europe," *Interavia* 54, no. 636 (November 1999): 47.

[xxx] Michael Dornheim, "Iridium, Overcapacity Worry Space Industry," 34.

[xxxi] While NASA officials are hoping for a fielded operational RLV replacement for the shuttle within the next decade, Arianespace officials expect their Ariane 5 and planned upgrades to remain competitive for the next 20 years. Source: Interviews with NASA and Arianespace officials on domestic and international travel.

[xxxii] B. Miller, "Satellites Free the Mobile Phone," *IEEE Spectrum* 35, no. 3 (March 1998): 26–35.

[xxxiii] Theresa Foley, "The Ka-Band Contestants," *Via Satellite* 14, no. 10 (October 1999): 20.

[xxxiv] Theresa Foley, "The Ka-Band Contestants."

[xxxv] Theresa Foley, "The Ka-Band Contestants."

[xxxvi] Pamela L. Meredith and Sean P. Fleming, "U.S. Space Technology Exports: The Current Political Climate," *Journal of Space Law* 27, no. 1 (1999): 35–53.

[xxxvii] Andrew Pollack, "Export Rules Are Said to Be a Threat to Satellite Industry," *The New York Times*, 1 August 1999, A23.

[xxxviii] Aerospace Industries Association, *Modernize the Export Control System*, 07 February 2000, http://aiaaerospace.org/issues/election2000/export_control_elect2000.pdf.

[xxxix] Shawn W. Crispin, "Technical Problem," *Far Eastern Economic Review* 162, no. 8 (25 February 1999): 31–32.

[xl] U.S. Department of Commerce, Bureau of Export Administration, *1999 Report on Foreign Policy Export Controls*, Chapter 12, 07 March 2000, www.bxa.doc.gov/PRESS/99/Repts/ForeignPolicy/TOC.html.

[xli] U.S Department of Commerce, *1999 Report on Foreign Policy Export Controls.*

[xlii] Barry Beneski, "Orbital Science Corp's Woes Continue with Loss of RADARSAT-2 Contract," *Satellite News* 22, no. 50 (20 December 1999): 1–2.

[xliii] *Export Controls—Better Interagency Coordination Needed on Satellite Exports*, GAO/NSIAD-99-182 (Washington, DC: General Accounting Office, 1999), 30.

[xliv] Andrew Pollack, "Export Rules Are Said to Be a Threat to Satellite Industry."

[xlv] John W. Douglass, "AIA CEO Warns of Continued Satellite Sales Plunge," *Satellite News* 22, no. 49 (13 December 1999): 1.

[xlvi] "Export Licensing Problems," *Space Business & Finance* 1, no. 3 (6 October 1999): 3.

[xlvii] William E. Stoney, "Outlook for the Future: Land Sensing Satellites in the Year 2000," *The Remote Sensing Tutorial On-Line Handbook* (CD-ROM), NASA Goddard SFC, 1998, 1–7.

[xlviii] Office of the Press Secretary, Press Sheet on Foreign Access to Remote Sensing Space Capabilities, 10 March 1994, http://www.fas.org/irp/offdocs/pdd23-2.htm.

[xlix] Larry K. Grundhauser, "Sentinels Rising," *Airpower Journal* (Winter 1998): 12.

[l] Department of Defense, Assistant Secretary of Defense for Command, Control, Communications and Intelligence, *Spectrum Management 2000*, 20.

[li] Joint Spectrum Center, *Spectrum Management and Space* (Washington, DC: Government Printing Office, 1999), 33.

[lii] U.S. Congress, Office of Technology Assessment, *The 1992 World Administrative Radio Conference: Issues for U.S. International Spectrum Policy—Background Paper* (Washington, DC: 1991), 9.

Return to the Top
Return to the ICAF Home Page